

CASSETTE-BASED EQUIPMENT: THE COMPUTED RADIOGRAPHY CASSETTE, IMAGING PLATE, AND READER

AREEJ ALOUFI

A decorative graphic element at the bottom of the slide, consisting of a blue trapezoidal shape with a white border, pointing downwards.

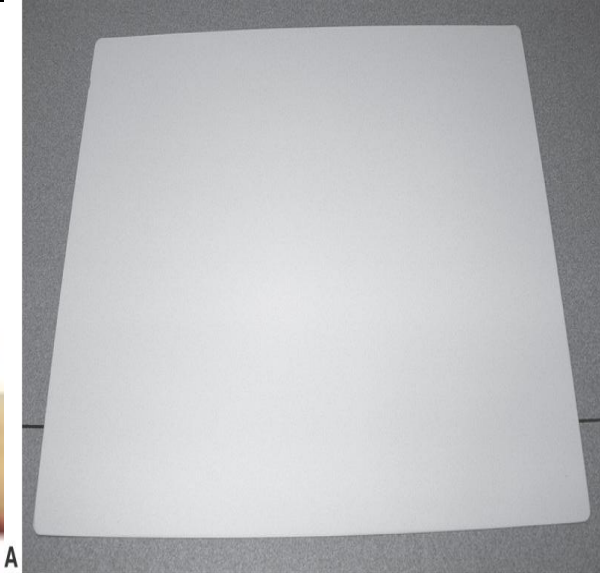
CR SYSTEM COMPONENTS

PSP – photostimulable phosphor plate
REPLACES FILM IN THE CASSETTE

- ▶ **CASSETTES**
- ▶ phosphor plates
- ▶ **ID STATION**
- ▶ **IMAGE PREVIEW (QC) STATION**
- ▶ **DIGITIZER**
- ▶ **VIEWING STATION**

COMPUTED RADIOGRAPHY EQUIPMENT

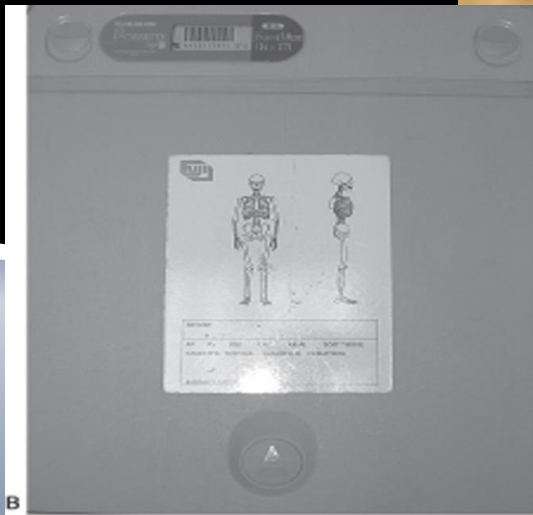
- Imaging plate



A

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- Cassette



B

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CASSETTE

- Looks like a film/screen cassette
- Durable, lightweight plastic
- Backed by aluminum
- No intensifying screens
- Antistatic material

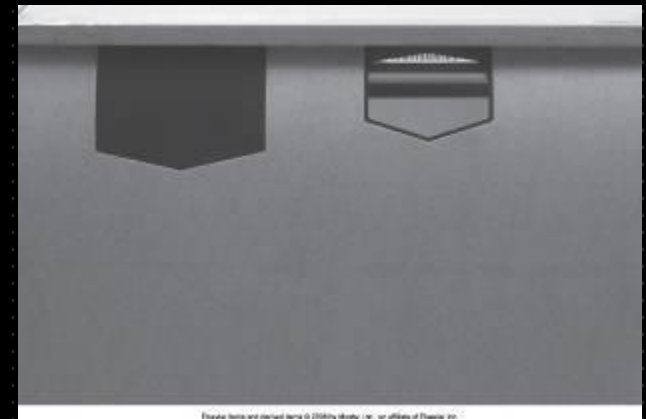


Cassette



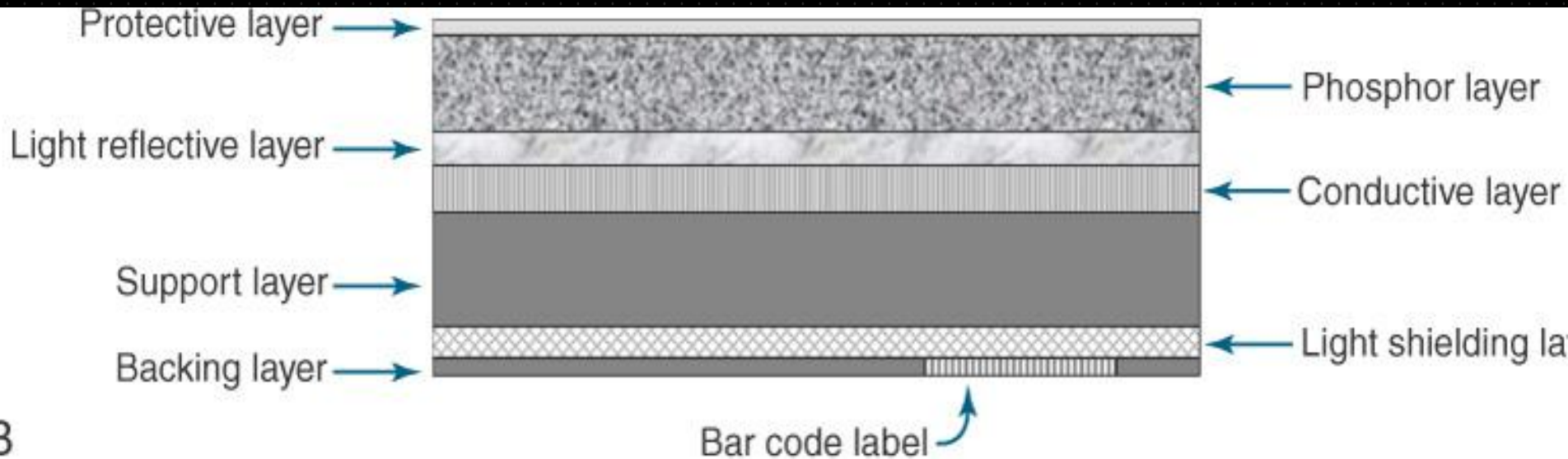
Aluminum Backing

Antistatic Material



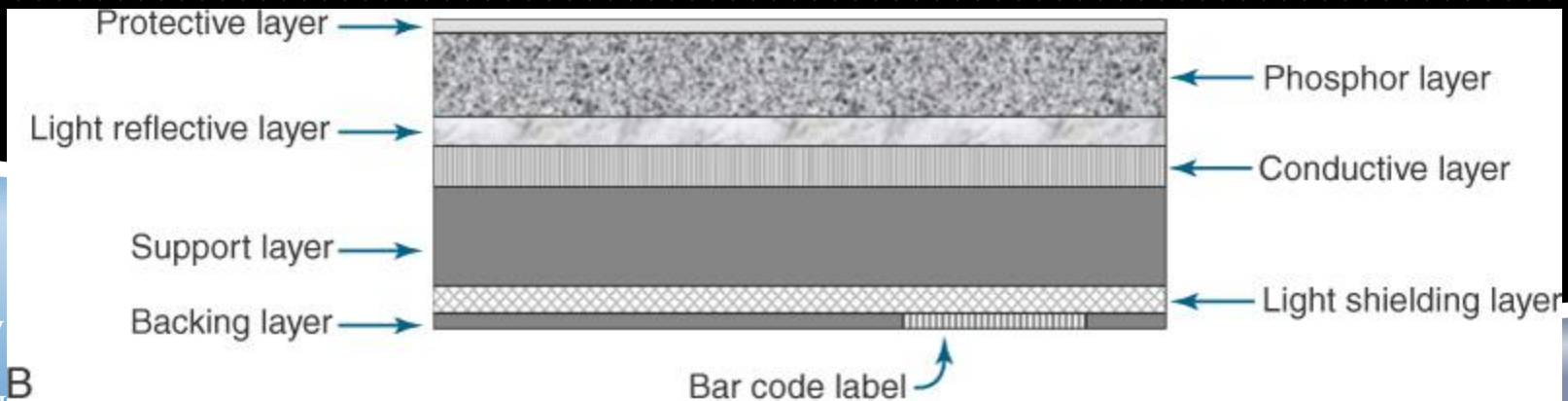
IMAGING PLATE

- Construction
- Image recorded on a thin sheet of plastic known as the imaging plate
- Consists of several layers:



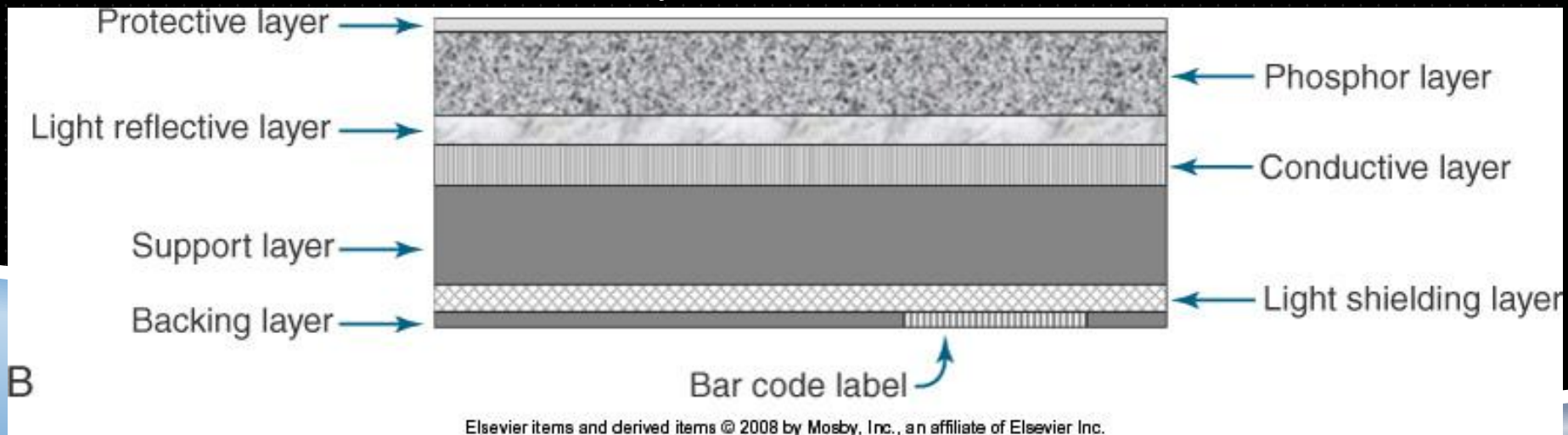
IMAGING PLATE

- ▶ **Protective layer:** A very thin, tough, clear plastic for protection of the **phosphor layer**
- ▶ Phosphor, or active, layer
 - ▶ A layer of **photostimulable phosphor** that “traps” electrons during exposure
 - ▶ Usually made of phosphors from the **barium fluorohalide**
 - ▶ May also contain a dye that differentially absorbs the stimulating laser light to prevent as much spread as possible



IMAGING PLATE

- ▶ **Reflective layer:** A layer that sends light in a forward direction when released in the cassette reader
 - ▶ May be black to reduce the spread of stimulating light and the escape of emitted light
 - ▶ Some detail lost in this process
- ▶ **Conductive layer:** A layer of material that will absorb and reduce static electricity



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IMAGING PLATE

- ▶ **Color layer:** Newer plates may contain a color layer, located between the active layer and the support that absorbs the stimulating light but reflects emitted light.
- ▶ **Support layer:** A semirigid material that gives the imaging sheet some strength.
- ▶ **Backing layer:** A soft polymer that protects the back of the cassette.



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CASSETTE AND IMAGING PLATE

- ▶ Cassette contains a **barcode** label on the cassette or on the imaging plate viewed through a window in the cassette.



- ▶ Label enables technologist to match the image information with the patient-identifying barcode on the exam request.

CR

- ▶ **PSP in cassette**
- ▶ **Digital image**
- ▶ **Scanned & read- CR reader**

COMPUTER

- ▶ **Image stored on computer**
- ▶ **Viewed on a Monitor**
- ▶ **Hard copy (film) can be made with laser printer**

GENERAL OVERVIEW

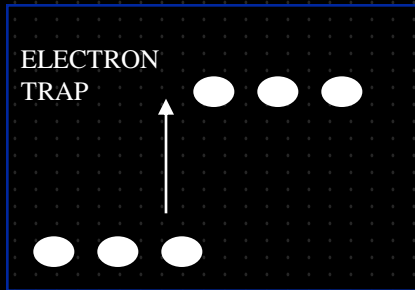
CR

- ▶ PSP cassette exposed by conventional X-ray equipment.
- ▶ Latent image generated as a matrix of trapped electrons in the plate.

CR Phosphor Plates

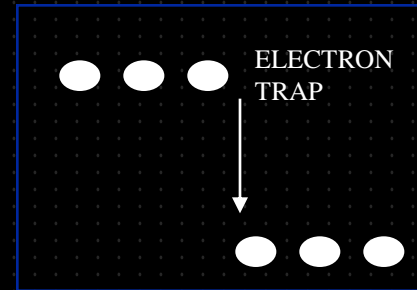
ABSORPTION

X-RAY



EMISSION

LASER STIMULATION



LIGHT



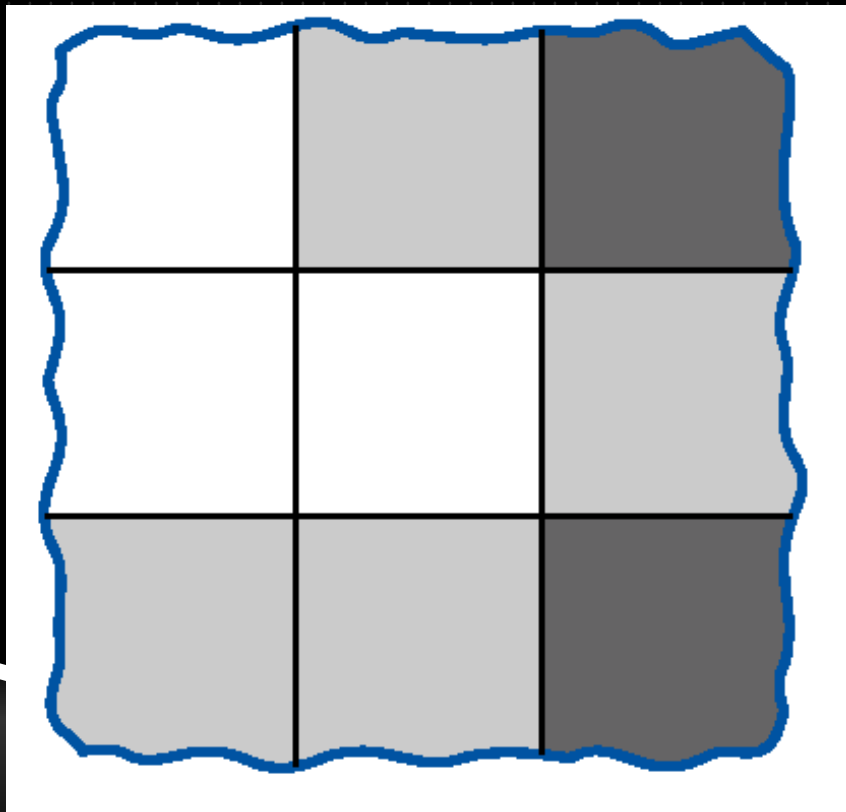
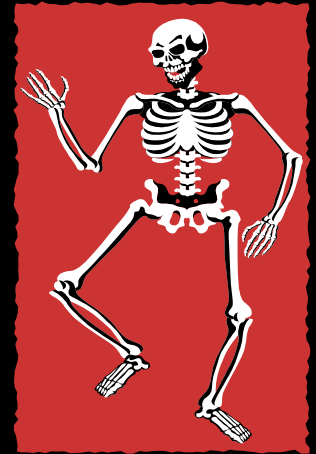
CR – PSP PLATE




- ▶ Stimulated by a RED LIGHT
- ▶ Energy is RELEASED in a form of BLUE light
- ▶ LIGHT captured by PMT –
- ▶ changed to a digital signal

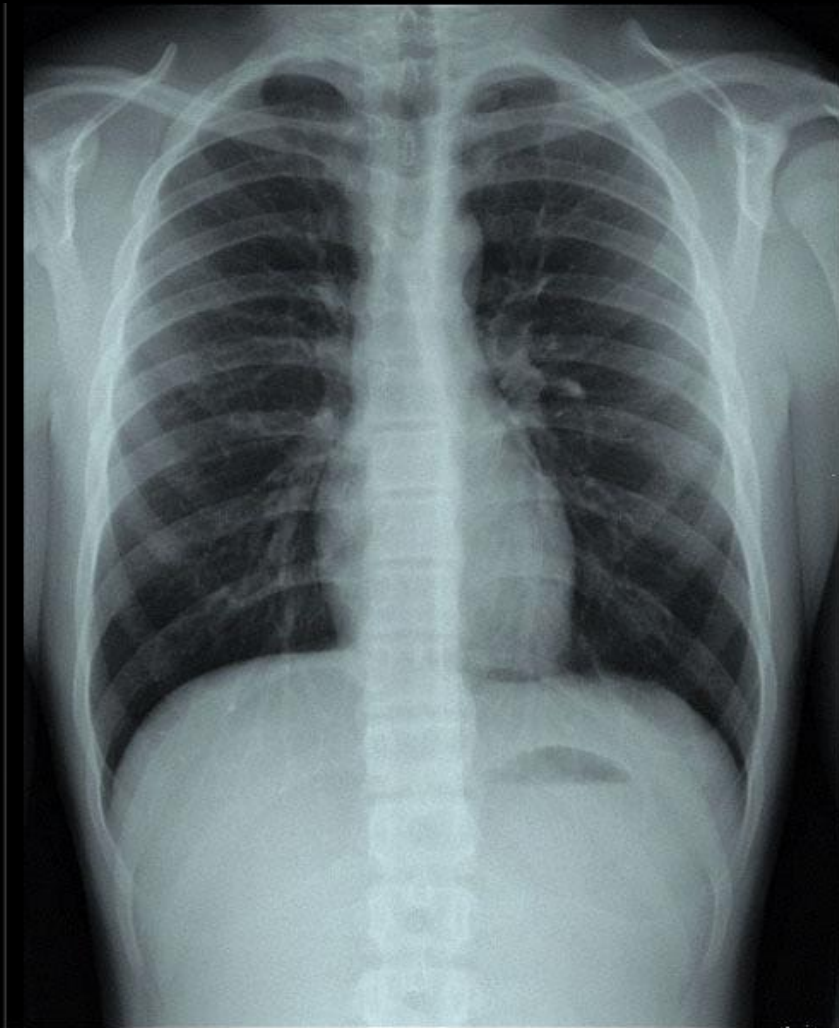
HOW CR WORKS

- ▶ Released light is captured by a PMT (photo multiplier tube)
- ▶ This light is sent as a digital signal to the computer
- ▶ The intensity (brightness) of the light – correlates to the density on the image

Statistical plots of the frequency of occurrence of each pixel's value



-  Bone: small signal (white)
-  Soft tissue: medium signal (grey)
-  Air: large signal (black)



Body Part

Chest

Projection

AP



Black Surround Mask



Black Bone



Edge Enhancement



EVP



1cm Scale



No Grid Detected



Left Marker



Right Marker



Print Internal Text Box
No Printer Selected



Print External Text Box
No Printer Selected



True-Size Print
No Printer Selected

John, Doe
Accession Number: 999999
Tech ID: JP

Patient ID: 999999

Cassette ID: 999999
Chest AP
Exposure Index: 1910



PREVIOUS IMAGE



NEXT IMAGE



SELECT DESTINATION



MAIN MENU



BACK

ERASING PLATE

- ▶ After image is recorded
- ▶ Plate is erased with high intensity white light
- ▶ and re-used

THE READER

- ▶ With CR systems, no chemical processor or darkroom is necessary.
- ▶ Cassette is fed into a reader:
 - ▶ Removes the imaging plate
 - ▶ Scans it with a **laser**, releasing the stored electrons

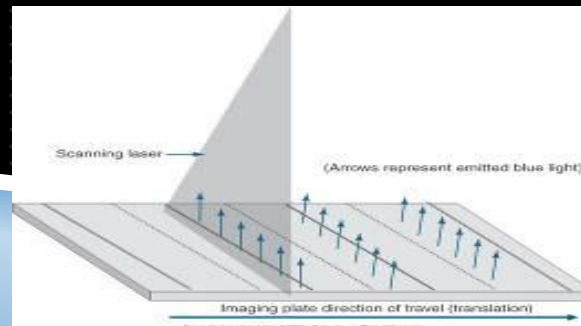


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THE LASER

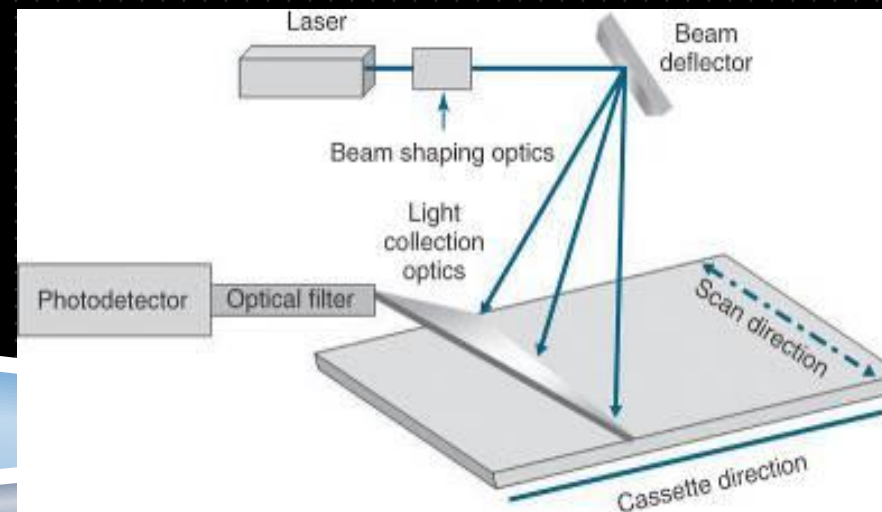
- ▶ Light Amplification by Stimulated Emission of Radiation.
- ▶ Laser creates and amplifies a narrow, intense beam of coherent light.
- ▶ Laser requires a constant power source to prevent output fluctuations.
- ▶ Laser beam passes through beam-shaping optics to an optical mirror, which directs the laser beam to the surface of the imaging plate.

- Reader scans the plate with red light in a zigzag, or raster, pattern.
- Laser gives energy to the trapped electrons.
- Red laser light is emitted at approximately 2 eV, which is necessary to energize the trapped electrons.
- Extra energy allows the trapped electrons to escape the active layer, where they emit visible blue light at an energy of 3 eV as they relax into lower energy levels.



USING THE LASER TO READ THE IMAGING PLATE

- ▶ The light collection optics direct the released phosphor energy to an optical filter and then to the photodetector.
- ▶ Although there will be variances between manufacturers, the typical throughput is 50 cassettes per hour.
- ▶ Some manufacturers claim up to 150 cassettes per hour, but based on average hospital department workflow, 50 cassettes per hour is much more realistic.



DIGITIZING THE SIGNAL

- ▶ In the process of digitizing the light signal, each phosphor storage center is scanned .
- ▶ The light is directed to the photomultiplier/charged coupled device that converts the light to an electronic signal.
- ▶ That electronic signal is digitized by an analog to digital converter (ADC).
- ▶ The ADC assigns each picture element or pixel a value that corresponds to a level of brightness.
- ▶ The entire image is divided into matrix of pixels based on the brightness of each pixel.
 - ▶ Each square is called a pixel or picture element.

DIGITIZING THE SIGNAL

- ▶ The typical number of pixels in a matrix range from about 512×512 to 1024×1024 and can be as large as 2500×2500 .
 - ▶ As the number of pixels in a matrix increase for the same field of view, the smaller the pixels have to be to fit into that area; the smaller the pixels, the greater the spatial resolution.
- ▶ The image is digitized by position (spatial location) and by intensity (gray level).
- ▶ Each pixel contains bits of information, and the gray level is determined by how many photons struck the imaging plate in that particular location.
 - ▶ Bit depth: The number of bits per pixel.

DIGITIZING THE SIGNAL

- ▶ The bit depth will be a factor in determining the quality of the image.
 - ▶ A bit value of 21 or one (1) represents a black and white image.
 - ▶ The larger the bit depth, the more shades of gray possible.
 - ▶ The more shades of gray, the more detail the image can display.
 - ▶ Each pixel can have a gray level between 2 (21) and 4096 (212).

SPATIAL RESOLUTION

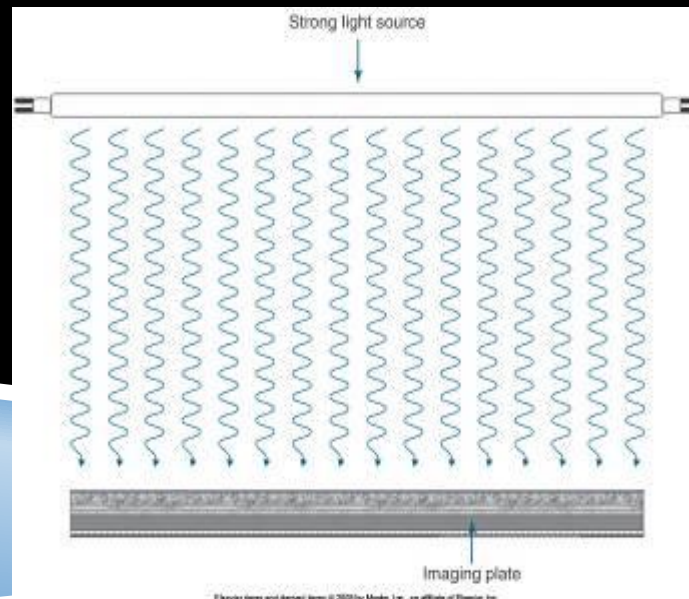
- ▶ Spatial Resolution
 - ▶ Refers to the amount of detail present in any image.
 - ▶ Phosphor layer thickness and pixel size determines resolution in CR.
 - ▶ The thinner the phosphor layer is, the higher resolution.

SPEED

- ▶ CR systems use the terms speed class or speed class of operation.
 - ▶ The speed class is a reflection of the amount of light (photostimulable luminescence [PSL]) emitted by the plate during the reading process and is related to the level of exposure received by the receptor.
 - ▶ The level of exposure received by the imaging plate indicates the speed class of operation.

ERASING THE IMAGE

- ▶ The process of reading the image returns most of electrons to a lower energy state.
 - ▶ Reading effectively removes the image from the plate.
- ▶ Imaging plates are extremely sensitive to scatter radiation.
 - ▶ Plates should be erased to prevent a buildup of background signal.
- ▶ Plates should be run at least once a week under an erase cycle to remove background radiation and scatter.



PREPROCESSING, PROCESSING, AND FORWARDING THE IMAGE

- ▶ Once the imaging plate has been read, the signal is sent to the computer.
 - ▶ Image is preprocessed.
- ▶ A monitor displays the image so that the technologist can do the following:
 - ▶ Review the image
 - ▶ Manipulate it if necessary (postprocessing)
 - ▶ Send it to the quality control station and ultimately to the picture archiving and communications system (PACS)

SUMMARY

- ▶ The cassette-based imaging system consists of a specially designed cassette made of durable, lightweight plastic.
- ▶ The imaging plate is multilayered with protective, phosphor, reflective, conductive, color, support, and backing layers.
- ▶ Barcodes are used to identify the cassette or imaging plate and exam request to link the imaging plate with the patient exam.

SUMMARY

- ▶ Barium fluorohalide crystals in the imaging plate release light energy that is stored in the conductive layer.
- ▶ The imaging plate reader uses a laser to scan the imaging plate, releasing the energy stored in the conductive layer as blue light.
- ▶ A photomultiplier amplifies the light and sends it to a signal digitizer.

SUMMARY

- ▶ The digitizer assigns a numeric value to each pixel in a matrix according to the brightness of the light and its position.
- ▶ Spatial resolution of the digital image is determined by the thickness of the phosphor layer and the number of pixels, which also effects resolution and sampling frequency. Cassette-based spatial resolution is approximately 2.55 lp/mm to 5 lp/mm (lower than 10 lp/mm of conventional radiography).

SUMMARY

- ▶ Because so many more densities are recorded in CR (wide dynamic range), images have increased contrast resolution but not increased spatial resolution.
- ▶ Because energy stored in the imaging plate is lost over time, imaging plates should be read as quickly as possible to avoid image information loss.
- ▶ Imaging plates are erased by exposing them to bright light such as fluorescent light.

SUMMARY

- The image is sent to the quality control station (which may be the same as the technologist workstation), where it is analyzed and sent to PACS for long-term storage.

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